

**SUPPORT FOR THE AMENDMENT**

Claims 1-3, 5-8, 10, and 11 are currently amended.

The claims have been amended to clarify claim language and for minor editorial purposes.

The claims are supported the claims and throughout the specification, as originally filed.

No new matter has been added by the amendments.

Upon entry of the amendments, claims 1-13 will be pending in the present application.

REQUEST FOR RECONSIDERATION

Applicants wish to thank Examiner Arancibia and Supervisory Patent Examiner Hassanzadeh for the courtesies extended to Applicants' representative at the interview held on March 8, 2006. At that time, Applicants' representative and the Examiners discussed an amendment to overcome the rejection of claims 6 and 10-13 under 35 U.S.C. § 112, second paragraph, and how the term "alkali" should be construed in claim 13. Applicants' representative also discussed the differences between the methods in the cited references and the claimed invention, and why it would not have been obvious to combine the references. The following remarks further expand upon the discussion with the Examiner.

The present invention provides a method of reclaiming silicon wafers, in which Cu not only deposited on a surface of silicon wafers but penetrated inside is removed, and Cu contamination inside of the silicon wafers is eliminated.

In particular, as shown above in claim 1, the method of reclaiming silicon wafers comprises:

a film removal process; a polishing process; a cleaning process; and a heating/removal process between the film removal process and the polishing process,

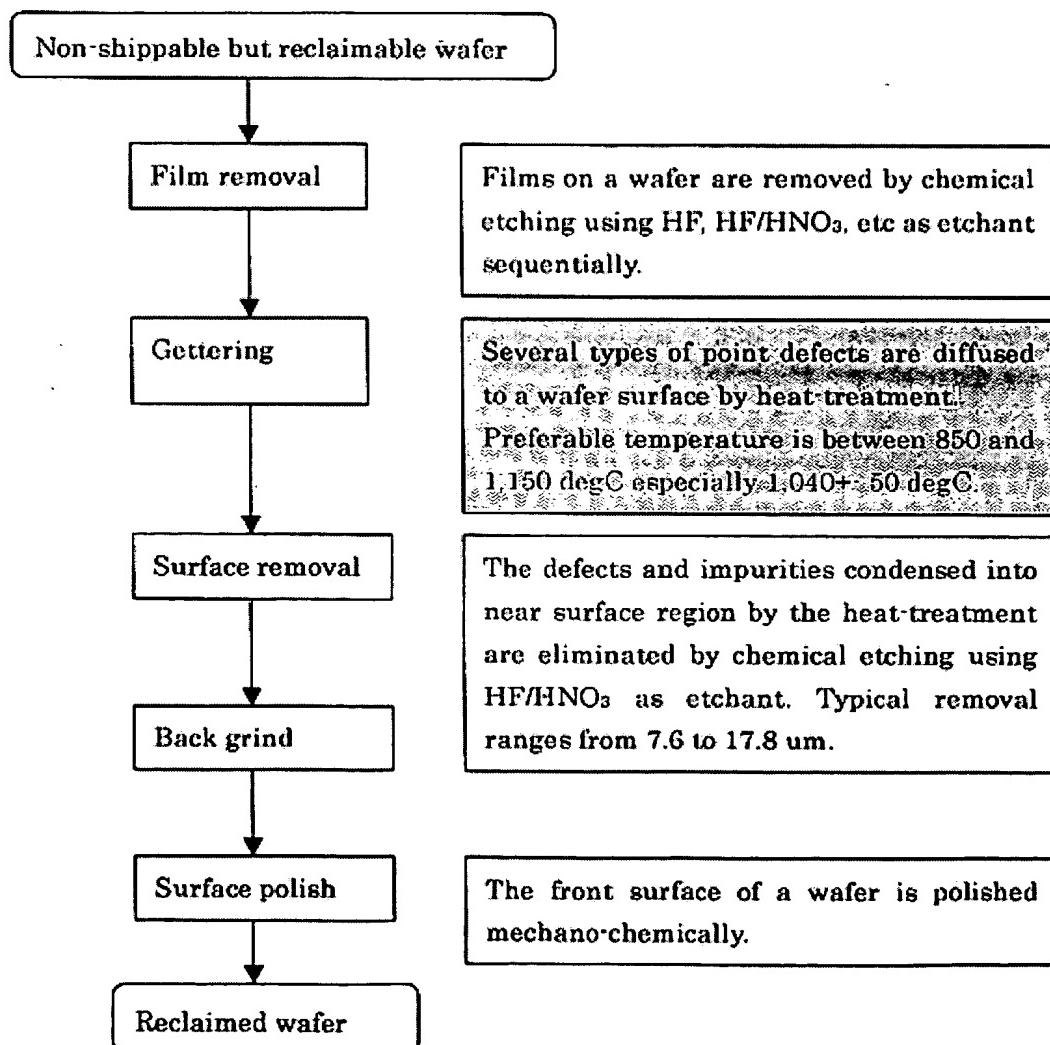
wherein the heating/removal process comprises heating the silicon wafer at 150-300 °C for 20 minutes to 5 hours and removing a surface part of the silicon wafer. Such a method is not described or suggested by the combination of the cited references in the Office Action, and any of the references of record.

Rejection Under 35 U.S.C. § 103(a)

The rejection of claims 1-3 under 35 U.S.C. § 103(a) as obvious over Lawrence (US Patent No. 3,3923,567) in view of Falster et al. (US Patent No. 6,100,167); claims 5-8, 10, and 11 as obvious further in view of Linn et al. (US. Patent No. 5,932,022); claim 4 as

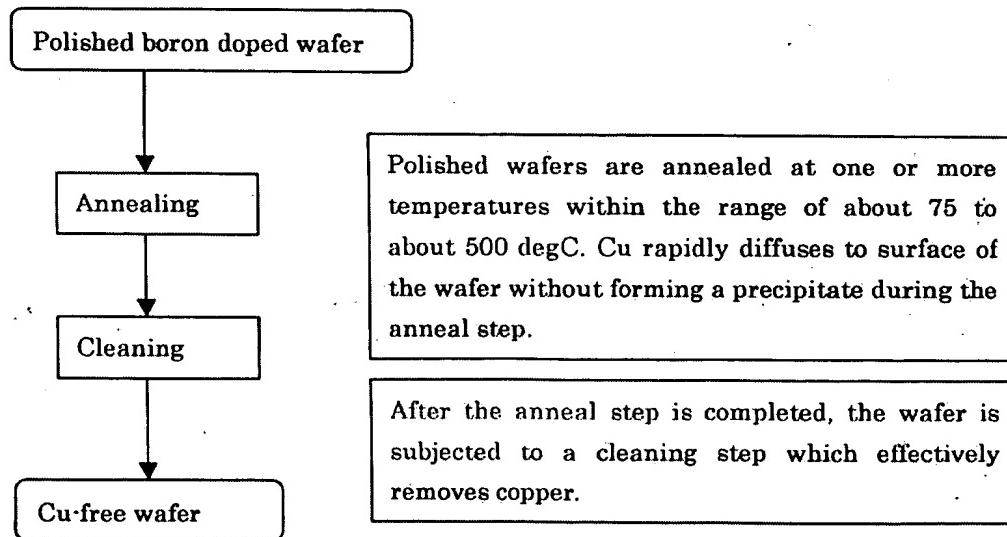
obvious further in view of Chai et al. (US Patent No. 5,837,662); and claims 9, 12, and 13 further in view of Chai et al. are respectfully traversed.

As admitted in the present Office Action, the Lawrence reference does not describe a method that includes “heating the silicon wafer is performed at 150-300 °C for 20 minutes [to] 5 hours.” (Present Office Action at page 3, paragraph 5). Moreover, it is apparent that the process does not aim to remove whatsoever Cu not only deposited on a surface of silicon wafers but penetrated inside the silicon wafers. For the Examiner’s convenience, Applicants provide the following schematic illustration of the method disclosed in the Lawrence reference.



In particular, the reference merely describes a process that “comprises the steps of stripping all external conducting and insulating layers from the wafer, gettering the wafer so as to draw excess point defects toward the surface of the wafer, and etching the surface of the wafer so as to effectively remove the unwanted impurities and surface lattice imperfections from the wafer prior to reclamation.” (Column 4, lines 10-16). Moreover, according to the reference, “[t]he getter step employs a furnace temperature of  $1040^{\circ} \pm 50^{\circ}\text{C}$  and a functionally infinite source of phosphorus for diffusion to maximize purifying effectiveness.” (Column 4, lines 21-22). Therefore, the reference clearly does not describe the reclamation method of the claimed invention.

Regarding Falster et al., the reference generally describes a method that includes the removal of copper from polished boron doped silicon wafers. In particular, the process may include annealing step that includes a broad range of heating temperatures, e.g., “of about 75 °C to about 500 C for a duration of 30 seconds to about 10 hours or more.” (Column 3, lines 61-64). For the Examiner’s convenience, Applicants provide the following schematic illustration of the method disclosed in the Falster et al. reference.



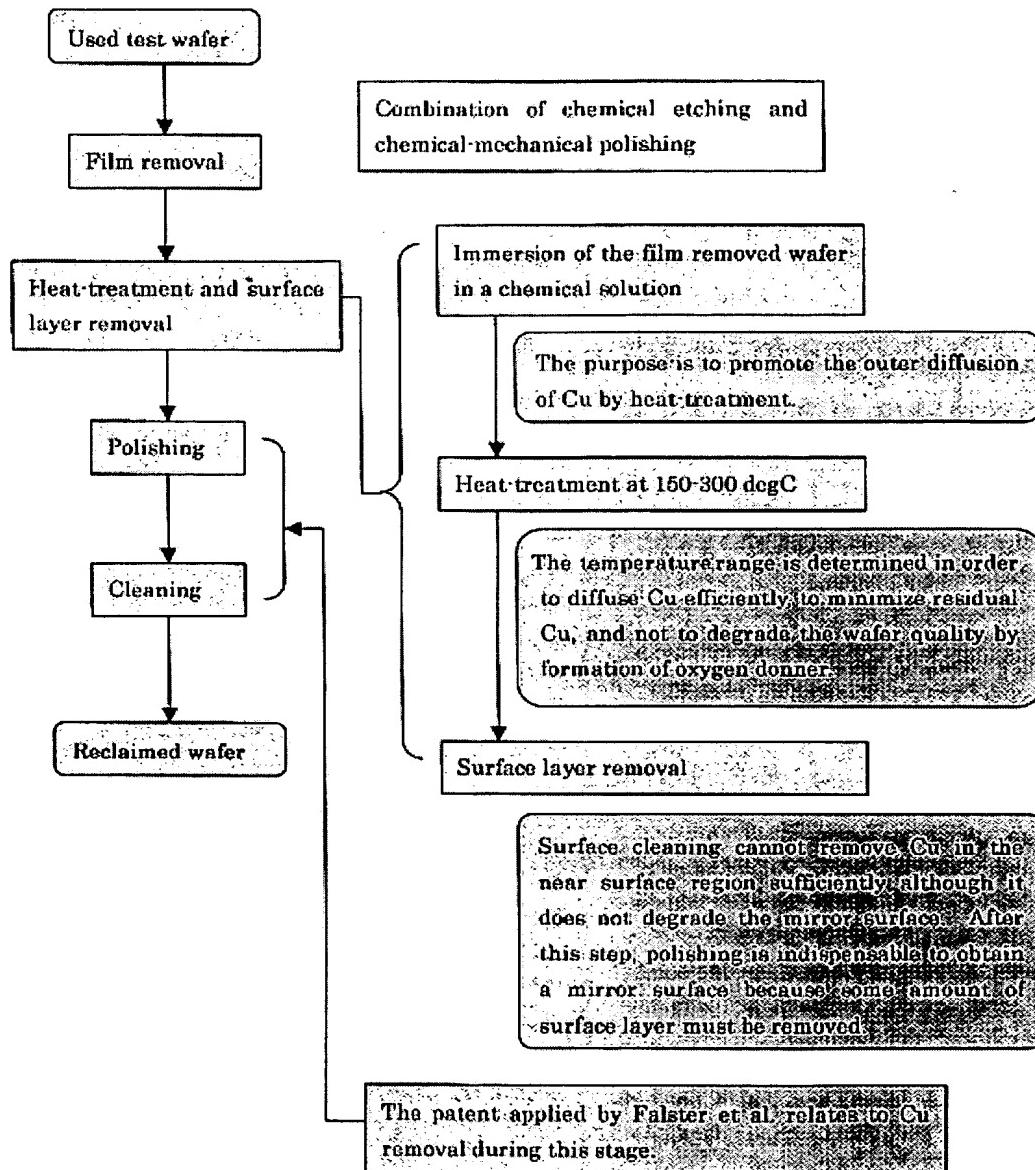
According to the present Office Action at page 4, lines 7-12, it would have been obvious to “replace the heating/removal process taught by Lawrence with the heating step

taught by Falster et al.” However, this temperature range is completely different from the temperature range for the getter step employed in the Lawrence reference, i.e.,  $1040^\circ \pm 50$  °C. Moreover, the Lawrence reference specifically teaches away from such a modification, i.e., Lawrence recites that the high temperature level is needed to “maximize purifying effectiveness”, as discussed above. Therefore, one would not have been motivated to combine these references, since they clearly teach away from each other. Further, it is noted that the Falster et al. reference does not even require the film removal process and polishing process of the claimed invention.

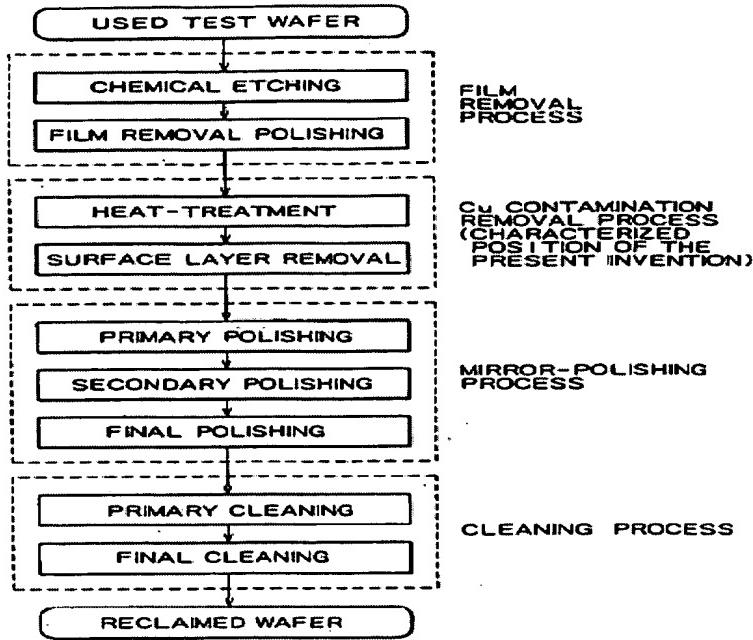
Regarding the Linn et al. and Chai et al. references, Applicants note that these references do not cure the deficiencies of Lawrence and Falster et al. references. In particular, in the present Office Action, it appears that the Examiner has merely relied on these references for describing the limitations of dependent claims 4-13. Moreover, it is noted that the Linn et al. reference discloses the immersion of a wafer in chemical solutions prior to annealing, but the purpose is to remove surface Cu and to prevent the surface Cu being driven into the wafer. On the other hand, the immersion process prior to the heat treatment in the present invention promotes the outer diffusion of Cu during the heat treatment. Therefore, the references, even in combination, do not include or require the combination of the film removal process, polishing process, cleaning process; and heating/removal process as described in amended claim 1.

In contrast to the references, the present invention, as discussed above, is characterized by a method of reclaiming silicon wafers including a film removal process, a polishing process, and a cleaning process, in which a heating/removal process for removing a silicon wafer surface part by heating at  $150\text{-}300$  °C for 20 minutes to 5 hours is included between the film removal process and the polishing process. A non-limiting schematic

illustration of the method of the claimed invention is provided below for the Examiner's convenience.



Applicants also note that a flow chart of the reclamation method of the present invention is illustrated in FIG. 6, which is reproduced below for the Examiner's convenience.



Applicants point out, as discussed in the present specification and shown in the above illustrations, that the “heating [in the heating/removal process] utilizes a phenomenon in which heating diffuses and migrates Cu penetrated inside of silicon to a surface. The present invention has a first feature that a maximum of a heating temperature is particularly specified in order to attain an original object of ‘reclamation of a silicon wafer.’” (Present specification at page 22, lines 22-27). Moreover, “[w]hen a heating temperature is less than 150 °C, a diffusion velocity for diffusing Cu penetrated between silicon crystalline lattices to a surface is slow (a remarkable long time is required), the temperature is not practical for the method of reclaiming silicon wafers.” (Present specification at page 23, lines 2-7). Further, the “maximum temperature [of 300 °C] is so defined as to guarantee quality of the silicon wafer. Specifically, the maximum temperature aims to prevent electric resistance from varying by the factors other than Cu by donor formation with oxygen between crystalline lattices of a silicon wafer etc., and also to avoid the donor formation so as not to make the reclamation of the silicon wafer difficult.” (Present specification at page 23, lines 9-16).

Applicants note that the heating process, including the required time range, is further discussed and exemplified on pages 9-13 of the present specification and FIG.2A and 2B.

Since the references alone do not describe a combination of process steps for reclamation of a silicon wafer in the manner presently claimed, and the Examiner has not shown that there would be motivation to combine the references, the claimed invention is not obvious in view of the references.

Therefore, in view of the foregoing reasons, Applicants respectfully request the withdrawal of the rejections under 35 U.S.C. § 103(a).

Rejection Under 35 U.S.C. § 112

The rejection of claims 6 and 10-13 under 35 U.S.C. § 112, second paragraph is obviated by amendment.

Claim 5, from which claim 6 depends, now recites “an immersion process comprising chemically processing the silicon wafer with a chemical processing liquid.” Accordingly, it is clear from the claim language that the chemical processing liquid refers to the immersion process.

Accordingly, withdrawal of the rejection is requested.

The rejection of claim 13 under 35 U.S.C. § 112, second paragraph is traversed.

According to the present Office Action at page 2, paragraph 3, “quaternary alkyl ammonium hydroxides are not either alkali hydroxides or alkali carbonates.” However, Applicants point out that the quaternary alkyl ammonium hydroxides are considered alkali hydroxides. In particular, Applicants note that the term “alkali” is not limited to or defined as an “alkali metal.” Rather, as known in the literature, “alkali” refers to “[a]ny substance that in water solution . . . turns blue, and has a pH value greater than 7.0,” i.e., a base. (Hawley’s CONDENSED CHEMICAL DICTIONARY, 14<sup>th</sup> Ed., p. 33 (2001)). The chemical dictionary further

Application No. 10/677,309  
Reply to Office Action of December 19, 2005

defines "strong bases (alkalies) . . . [as] sodium and potassium hydroxide, ammonium hydroxide, etc." (Id. at p. 117). (A copy of the relevant portions of the chemical dictionary are attached herewith for the Examiner's convenience).

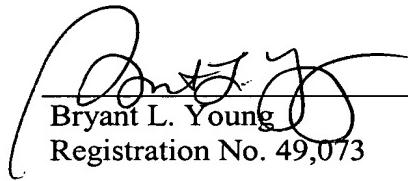
Accordingly, withdrawal of the rejection is requested.

Applicants submit that the application is now in condition for allowance. Early notification of such allowance is earnestly solicited.

Should the Examiner deem that any further action is necessary to place this application in even better form for allowance, the Examiner is encouraged to contact Applicants' undersigned representative at the below listed telephone number.

Respectfully submitted,

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*Hawley's*  
**Condensed Chemical  
Dictionary**  
*Fourteenth Edition*

Revised by  
**Richard J. Lewis, Sr.**



JOHN WILEY & SONS, INC.

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**alkali.** Any substance that in water solution is bitter and is irritating or caustic to the skin and mucous membranes, turns litmus blue, and has a pH value greater than 7.0. The alkali industry produces sodium hydroxide, sodium carbonate (soda ash), sodium chloride, salt cake, sodium bicarbonate, and corresponding potassium compounds. See base; pH; alkali metal.

**alkali blue.** Class name for a group of pigment dry powders prepared by the phenylation of *p*-rosaniline or fuchsin, followed by drowning in hydrochloride acid, washing, and sulfonating. Alkali blue on a weight basis has the highest tinting strength of all blue pigments. The presscake may be "flushed" with vehicle to replace the water in the pulp. Use: Printing inks, interior paints.

**alkali cellulose.** The product formed by steeping wood pulp with sodium hydroxide, the first step in the manufacture of viscose rayon and other cellulose derivatives.

See carboxymethylcellulose.

**alkali metal.** A metal in group IA of the periodic table, i.e., lithium, sodium, potassium, rubidium, cesium, and francium. Except for francium, the alkali metals are all soft, silvery metals, which may be readily fused and volatilized; the melting and boiling points becoming lower with increasing atomic weight. The density increases with (but less rapidly than) the atomic weight, the atomic volume therefore becoming greater as the series is ascended. The alkali metals are the most strongly electropositive of the metals. They react vigorously, at times violently, with water; within the group itself, the basicity increases with atomic weight, that of cesium being the greatest.

**alkalimetry.** The measurement of the concentration of bases or of the amount of free base present in a solution by titration or some other means of analysis.

**alkaline earth.** An oxide of an alkaline earth metal (lime).

**alkaline-earth metals.** Calcium, barium, strontium, and radium (group IIA of the periodic table). In general they are white and differ by shades of color or casts; are malleable, extrudable, and machinable; may be made into rods, wire, or plate; are less reactive than sodium and potassium and have higher melting and boiling points.

**alkaloid.** A basic nitrogenous organic compound of vegetable origin. Usually derived from the nitrogen ring compounds pyridine, quinoline, isoquinoline, and pyrrole, designated by the ending -ine. Though some are liquids, they are usually colorless, crystalline solids, having a bitter taste, and which combine with acids without elimination of water.

They are soluble in alcohol, insoluble or sparingly soluble in water. Examples are atropine, morphine, nicotine, quinine, codeine, caffeine, cocaine, and strychnine.

**alkane.** See paraffin (1).

**alkanesulfonic acid, mixed.**  $\text{RSO}_3\text{H}$  ( $\text{R}$  is methyl, ethyl, propyl, mixed). Trade designation for a mixture of methane-, ethane-, and propane sulfonic acids. A strong nonoxidizing, nonsulfonating liquid acid which is thermally stable at moderately high temperatures.

**Properties:** Light amber liquid; sour odor. Mp below  $-40^\circ\text{C}$ , bp  $120\text{--}140^\circ\text{C}$  (1 mm), d  $1.38$  ( $20^\circ\text{C}$ ), pH (1% solution)  $1.15$ . Very corrosive. Miscible with water and saturated fatty acids.

Use: Catalyst; intermediate, reaction medium.

**"Alkanol" [Du Pont].** TM for a series of fatty alcohol-ethylene oxide condensation products used as nonionic surface-active agents in detergents and dispersing and emulsifying agents in paper, leather, and textiles. These include grades OA, OE, OJ, OP, and HC. 189-S is a saturated hydrocarbon sodium sulfonate. B and BG are sodium alkylnaphthalene sulfonates. Sulfur is tetrahydronaphthalene sodium sulfonate.

**alkanolamine.** (alkylolamine). A compound such as ethanolamine,  $\text{HOCH}_2\text{CH}_2\text{NH}_2$ , or triethanolamine,  $(\text{HOCH}_2\text{CH}_2)_3\text{N}$ , in which nitrogen is attached directly to the carbon of an alkyl alcohol. See specific compound.

**alkene.** See olefin.

**alkoxyaluminum hydrides.** ( $\text{H}_n\text{AlOR}_{3-n}$ ). A group of reducing agents especially useful in converting epoxides to alcohols. Derived by reaction of aluminum hydride with the corresponding alcohol in tetrahydrofuran.

**alkyd resin.** A thermosetting coating polymer, chemically similar to polyester resins, conventionally made by condensation and polymerization of a dihydric or polyhydric alcohol (ethylene glycol or glycerol) and a polybasic acid (phthalic anhydride), usually with a drying oil modifier. The process requires heating at  $230\text{--}250^\circ\text{C}$  for up to 12 hours. A new and quite different method utilizes epoxy addition polymerization, in which a mixture of glycidyl esters and organic acid anhydrides is heated with a metallic catalyst at  $100^\circ\text{C}$  or less for only two to four hours. Cost and energy savings and improved application performance are realized by this process. Use: Alkyd resins are used as vehicles in exterior house paints, marine paints, and baking enamels. Molded alkyd resins are used for electrical components, distributor caps, encapsulation, and a variety of similar applications.

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**barytes.** See barium sulfate.

**"Basacryl" [BASF].** TM for a series of cationic dyestuffs for the dyeing and printing of polyacrylonitrile fiber.

**basal metabolism.** See metabolism.

**"Basazol" [BASF].** TM for dyes used in printing and dyeing paper composed of cellulosic fibers.

**base.** Any of a large class of compounds with one or more of the following properties: bitter taste, slippery feeling in solution, ability to turn litmus blue and to cause other indicators to take on characteristic colors, ability to react with (neutralize) acids to form salts. Included are both hydroxides and oxides of metals. Water-soluble hydroxides such as sodium, potassium, and ammonium hydroxide undergo ionization to produce hydroxyl ion ( $\text{OH}^-$ ) in considerable concentration, and it is this ion that causes the previously mentioned properties common to bases. Such a base is strong or weak according to the fraction of the molecules that breaks down (ionizes) into positive ion and hydroxyl ion in the solution. Base strength in solution is expressed by pH. Common strong bases (alkalies) are sodium and potassium hydroxides, ammonium hydroxide, etc. These are caustic and corrosive to skin, eyes, and mucous membranes. The pH range of basic solutions is from 7.1 to 14. Modern chemical terminology defines bases in a broader manner. A Lowry-Brønsted base is any molecular or ionic substance that can combine with a proton (hydrogen ion) to form a new compound. A Lewis base is any substance that provides a pair of electrons for a covalent bond with a Lewis acid. Examples of such bases are hydroxyl ion and most anions, metal oxides, and compounds of oxygen, nitrogen, and sulfur with nonbonded electron pairs (such as water, ammonia, hydrogen sulfide).

See Lewis electron theory for hard and soft bases.

**base saponification number.** The number of milligrams of KOH equivalent to the amount of acid required to neutralize the alkaline constituents present after saponifying 1 g of sample.

**BASF process.** A process for producing acetylene by burning a mixture of low-molecular weight hydrocarbons (as natural gas) with oxygen to produce a temperature of 1485°C. The combustion products and cracked gases are quickly chilled by scrubbing with water, and the acetylene is separated by distillation and solvent extraction from ethylene, carbon monoxide, hydrogen, and other reaction products. The Sachsse process is similar.

**basic.** Descriptive of a compound that is more alkaline than other compounds of the same name, e.g., lead carbonate, basic; basic salt.

**basic chemicals.** See heavy chemicals.

**basic dichromate.** See bismuth chromate.

**basic fuchsin.** (CI 42500).

CAS: 569-61-9. A mixture of three parts pararosaniline acetate and one part pararosaniline hydrochloride.

**Grade:** Certifiable.

**Use:** For staining *Tubercle bacillus* and in distinguishing between the *coli* and *aerogenes* types of bacteria in the Endo medium. Also used in the periodic acid-Schiff (PAS) method, in the Feulgen stain, and in the Gomoris aldehyde-function method for staining elastic tissue.

**basic lining.** A furnace lining containing basic compounds that decompose under furnace conditions to give basic oxides. The usual basic linings contain calcium and magnesium oxides or carbonates.

**basic oxide.** An oxide that is a base or that forms a hydroxide when combined with water and/or that will neutralize acidic substances. Basic oxides are all metallic oxides, but there is a great variation in the degree of basicity. Some basic oxides, such as those of sodium, calcium, and magnesium, combine with water vigorously or with relative ease and also neutralize all acidic substances rapidly and completely. The oxides of the heavy metals are only weakly basic, do not dissolve or react with water to any extent, and neutralize only the more strongly acidic substances. There is a gradual transition from basic to acidic oxides, and certain oxides, such as aluminum oxide, show both acidic and basic properties.

See base.

**basic research.** See fundamental research.

**basic salt.** A compound belonging in the category of both salt and base because it contains OH (hydroxide) or O (oxide) as well as the usual positive and negative radicals of normal salts. Among the best examples are bismuth subnitrate, often written  $\text{BiONO}_3$ , and basic copper carbonate,  $\text{Cu}_2(\text{OH})_2\text{CO}_3$ . Most basic salts are insoluble in water, and many are of variable composition.

**basic slag.** A slag produced in the manufacturing of steel. It contains a variable amount of tricalcium phosphate, calcium silicate, lime, and oxides of iron, magnesium, and manganese. Used as a fertilizer for its phosphorus and lime.

See slag.

**basis metal.** In electroplating, the metal that is being coated constitutes the cathode. It may be any of a large number of metals.

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